



***Deliverable For:***

**Gateway Cities Traffic Signal Synchronization and  
Bus Speed Improvement Project**

**I-5/Telegraph Road Corridor**

***Deliverable 3.1.2***

**Advanced Traffic Management Systems**

**(ATMS)**

**User Requirements**

**Final**

**Version 1.0**

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## 1.0 INTRODUCTION

### 1.1 Background

The County of Los Angeles Department of Public Works Traffic Signal Synchronization, Operation and Maintenance (SOM) has proven successful in creating an institutional infrastructure to coordinate the activities of the agencies responsible for traffic signal operations in the County. A key feature of this infrastructure is the Forums - groups of bordering agencies created to encourage and promote inter-agency cooperation. These Forums have enabled funding to be targeted at infrastructure improvements along arterial and arterial/freeway corridors in the County's Sub-Regions. Such projects are a critical part of what will eventually be a network of integrated ITS systems in Los Angeles County and in Southern California.

The I-5/Telegraph Road Corridor is one such project which will result in arterial infrastructure improvements along Telegraph Road in the South-East LA County (Gateway Cities) Forum. The Project area contains 39 intersections in 8 different jurisdictions, comprising 6 cities, the County and Caltrans.

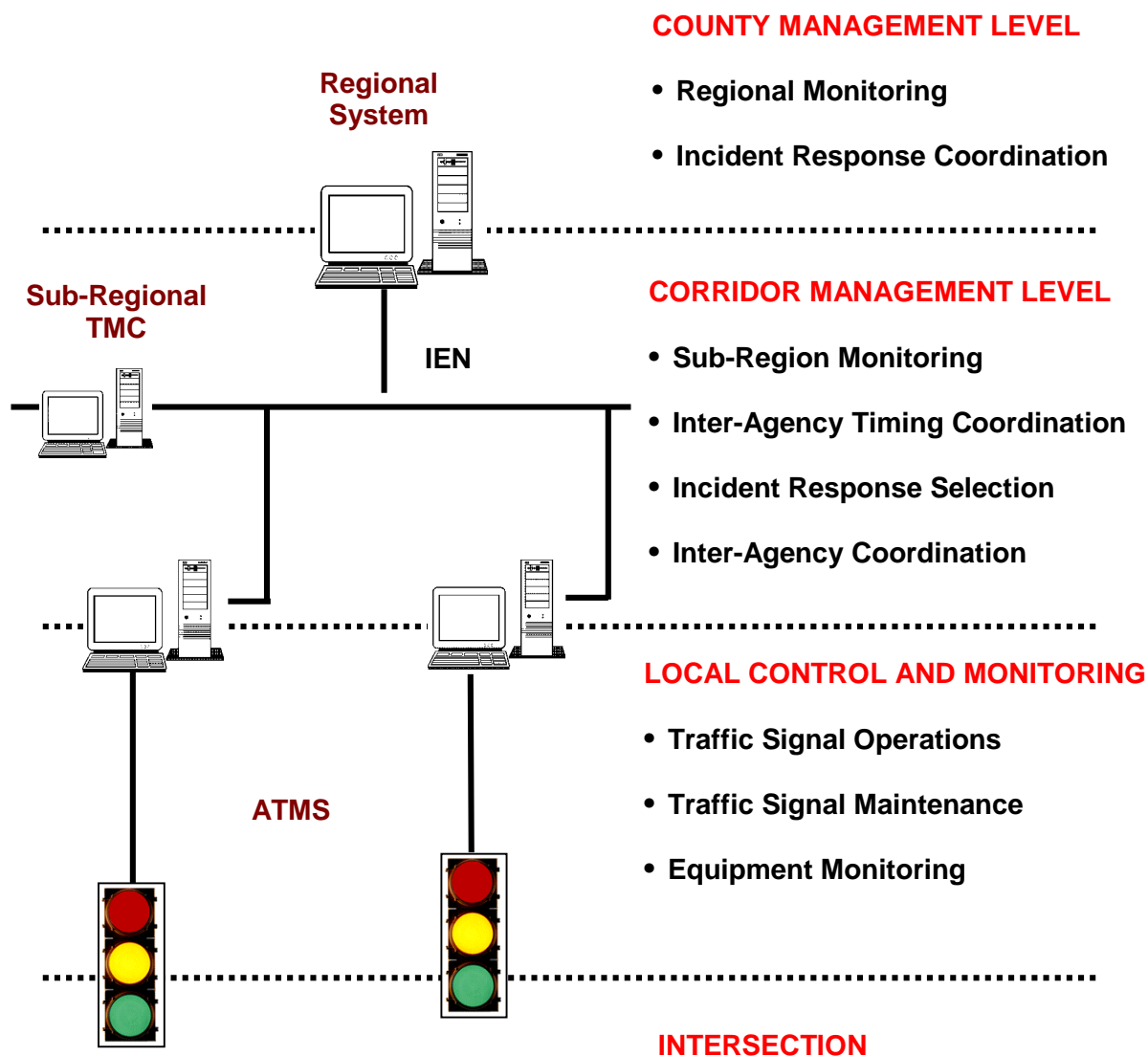
The objective of this Project is to design, develop and deploy traffic control systems in the Corridor so that the signals along I-5/Telegraph Road can be synchronized across the jurisdictional boundaries. This Project concentrates on the needs of the agencies in this Corridor with respect to signal synchronization along Telegraph Road and recommends improvements to field infrastructure (including controllers, loops, detectors, and communications) and central traffic control systems to meet those needs.

When successfully completed, each of the agencies responsible for traffic signal operations in the I-5/Telegraph Road Corridor will have full access to a TCS that monitors and controls the traffic signals under their jurisdiction. Agencies will be able to synchronize their signals with neighboring agencies, and exchange traffic information in real-time. Agencies will also be able to exchange data with other agencies in the SELAC region. This will allow the agencies to respond to recurrent and non-recurrent congestion in a coordinated fashion across the jurisdictional boundaries.

### 1.2 Conformance With the National ITS Architecture

The County DPW has developed a system architecture for integrating Advanced Traffic Management Systems (ATMS) for arterial traffic control systems into a regional framework to support the above operational goals. This is the Countywide Arterial Management System (CAMS) and is represented in Figure 1.1 and is the architecture that will be followed in the design of the I-5/Telegraph Road Project. The CAMS is described in Section 1.3.

The County has decided that the Project must follow the guidelines and rules laid out by the FHWA to conform to the National ITS Architecture (NITSA) in order to enjoy the resultant benefits. In order for the Project to satisfy the ITS rulemaking policy issued by the FHWA on January 8, 2001, there are two aspects of the rule making that must be fulfilled. The first is that the CAMS must be in conformance with the rules for a regional ITS architecture, and the second is that the Project must meet the relevant requirements of the rulemaking policy.



**Figure 1.1: The Countywide Arterial Management System Architecture (CAMS)**

The CAMS architecture is in conformance with the National ITS Architecture because it meets the following criteria:

- Describes planned ITS services/functions.
- Includes the subsystems and organizations relevant to the area.
- Describes information exchanges planned between regional subsystems/organizations.
- Provides a regional framework for ITS integration.
- Guides Project definition.

The relevant sections of the rule making policy for both the CAMS and this Project are Project Requirements and Major ITS Project Requirements. The Project can be considered a Major ITS project because it involves Traffic Management Centers and is part of the deployment of a major new integrated traffic signal system.

The Project Requirements of the rulemaking are:

1. All ITS projects be developed using a systems engineering approach.

This is a requirement of the contract under which the project is being carried out and is reflected in the tasks that form the scope of work. This is further examined in Section 1.6, below.

2. All ITS projects be designed in accordance with their regional ITS architecture.

The CAMS is specifically identified in the Regional Architecture as defined in the Los Angeles/Ventura County ITS Strategic Deployment Plan. By following the precepts of the CAMS architecture, the project's design should be in accordance with that architecture.

### **1.3 The Countywide Arterial Management System Architecture**

The CAMS architecture supports traffic signal operations in three levels (see Figure 1.1). The local level comprises the day-to-day, traffic signal operations carried out by the individual agency – signal timing, maintenance and response to local traffic conditions and events. The corridor level supports inter-agency coordination and joint signal operations – coordination across jurisdictional boundaries, exchange of local traffic data, and joint response to traffic conditions and events that affect more than one jurisdiction. The final level is the regional level. This permits the arterials of regional significance to be monitored and managed as a single entity (as Caltrans does with the freeway system). Multi-agency, cross-corridor data exchange is supported permitting a countywide response to traffic conditions and major events.

The physical elements of the architecture are ATMS, workstations to display shared data (which may or may not be combined with the traffic control system), and servers for the collection/transfer of data and to support corridor and regional functions. These components are connected via a communications network known as the Information Exchange Network (IEN). The design of the IEN is being developed as part of the East San Gabriel Valley (ESGV) Pilot Project. The initial application of this structure in the Gateway Cities region is being done under the auspices of the I-105 Corridor Project which has jurisdictions in common with the I-5 Telegraph Road Project.

The I-5/Telegraph Road Project assumes the availability of the IEN at the corridor and regional levels as provided by the I-105 Corridor Project. The I-5/Telegraph Road focuses upon the selection and integration of multiple ATMSs (for the Cities included in the I-5/Telegraph Road Corridor Project) into the CAMS using the IEN at the local level. The eventual design will include IEN workstations at the local level. These are initially being defined and implemented as part of the ESGV Pilot Project. Additional functionality supporting the Corridor Management Level tasks will be incorporated as part of the I-105 Corridor Project. The design of the traffic control systems in this I-5/Telegraph Road Project will take into account the interface to the IEN and the requirements of the CAMS at the local level.



## 1.4 Purpose of Document

This document is being presented for the purpose of compiling User Requirements for the I-5 Telegraph Road Corridor Project. The requirements defined are for Advanced Traffic Management Systems (ATMS) to be used by the signal operating agencies for traffic signal control and monitoring. The requirements are those which represent the use of the system definition from an operational standpoint.

This document is organized into the following Sections:

- **Introduction** – Presents the Project background and introduces the document.
- **Concept of Future Operations** – Presents the operational and system concepts, placing the advanced traffic management systems in the context of multi-agency operations.
- **User Requirements** – Presents the User Requirements as derived from previous work with these agencies and from interviews with each operational agency.
- **Use Case Analysis** - Provides the use cases that define the functionality of the ATMS. This Section captures the users' expectations of the functionality of the system and expresses them clearly in terms that system developers can follow.
- **Requirements Traceability** – Describes the requirements tracking process and the foundations of the Traceability Matrix.

## 1.5 Regional Area and Agencies Involved

The I-5/Telegraph Road Corridor Project spans many jurisdictional boundaries. It will be integrated, or have the ability to integrate, with many other projects and existing systems in the region. The following cities and agencies are involved in the Project:

- Commerce
- Downey
- La Mirada
- Montebello
- Pico Rivera
- Santa Fe Springs
- Los Angeles County Department of Public Works
- Caltrans District 7

## 1.6 Review of the Requirements Process

The approach to the design and development of the ATMS and other CAMS components follows, under the LA County DPW's oversight, the System Engineering process as first defined by Carnegie Mellon University and now required by the FHWA rulemaking described in Section 1.2. The process dictates that the development and integration of complex computer systems follow a systematic verification of user needs, identification of system requirements, preparation of a high-level design which fully envelopes the system requirements and final development of a detailed design which fits the high level design. Throughout the process, key analysis and

trades are conducted including cost/benefit, performance needs, technology assessment, implementation of risk, operations and maintenance.

As part of the I-105 Corridor Project, a User Requirements survey was carried out using a strategy to promote substantial quality information and to maximize agency participation. This assessment process required three steps:

- (1) definition of existing capabilities and development of a requirements questionnaire/survey;
- (2) a workshop to discuss questionnaires; and
- (3) individual meetings with the separate agencies/cities to follow-up on information provided by the survey.

The User Requirements survey indicated a high level of willingness to cooperate and coordinate signal operations with other agencies. Pre-approved signal timing plans in response to special events and incidents such as, freeway closure can be implemented by all involved agencies. This highlights the importance of reaching common understandings and agreements on the level of cooperation, management, and control of signals under all types of situations including the development of emergency response plans. These plans would enable quick, pre-approved, and effective responses to be implemented to manage traffic patterns that influence the freeway and/or the arterial system.

The information that was received from the meetings and workshops was compiled and presented in the I-105 Corridor Project User Requirements Report. It is this Report that forms the basis of this document.

A detailed questionnaire survey has already been carried out with the regional agencies and three of the local agencies involved in the I-5 Telegraph Road Corridor. The scope of this project was therefore defined as being the identification of any additional requirements, especially for the three agencies previously not surveyed. This was achieved by carrying out one-on-one interviews with all eight agencies. The interviews, together with the inventory of current equipment, have been documented in Deliverables 2.1 and 2.3: Stakeholder's Operational Objectives Individual City Reports.

The results of the individual agency interviews have been translated to requirements and use cases. These have been incorporated into the I-105 Corridor Project User Requirements Report document to produce the I-5 Telegraph Road User Requirements.

A powerful technique in system design is Use Case modeling. This method defines the functionality of the system from the standpoint of the user, i.e. what can the user do with the system. Use cases for a traffic control system have been defined as part of the San Gabriel Valley Pilot Project and used in the I-105 Corridor Project. The final part of the User Requirements Analysis for the I-5/Telegraph Road Corridor takes these Use Cases and allocates the User Requirements to them. This provides the link between the User Requirements and the Functional Requirements that will be the next stage in the system design. This also helps identify which of the User Requirements relate to system, and performance requirements.

## 1.7 Referenced Documents

The following documents have been used as reference material in the preparation of this report:

- Deliverables 2.1 and 2.3: Stakeholder's Operational Objectives Individual City Reports
- I-105 Corridor Project User Requirements Report
- San Gabriel Valley Pilot Project - System Design Report, Final Version 1.0

## 2.0 CONCEPT OF FUTURE OPERATIONS

### 2.1 System Concept

Under the I-105 Corridor Project, the CAMS architecture of Figure 1.1 will be deployed as the system concept shown in Figure 2.1. The deployed systems will provide the cities and agencies with the ability to synchronize and remotely manage and control their traffic signal systems. The Project will provide a system that will control and coordinate traffic signal operations along arterials that are parallel to freeways. The surveillance, detection, management, communication, and control of corridor traffic will be performed at each city's site, Local Traffic Control Center (Local TCC) and information will be shared between cities and agencies through a Sub-Regional TMC. The Sub-Regional TMC will act as central communications hub. It will be possible for a local agency to delegate some level of control to the Sub-Regional TMC based on pre-defined policies and procedures. The Sub-Regional TMC will share information/control with Caltrans Freeway Management System (FMS). The Sub-Regional TMC will also interface to the County TMC.

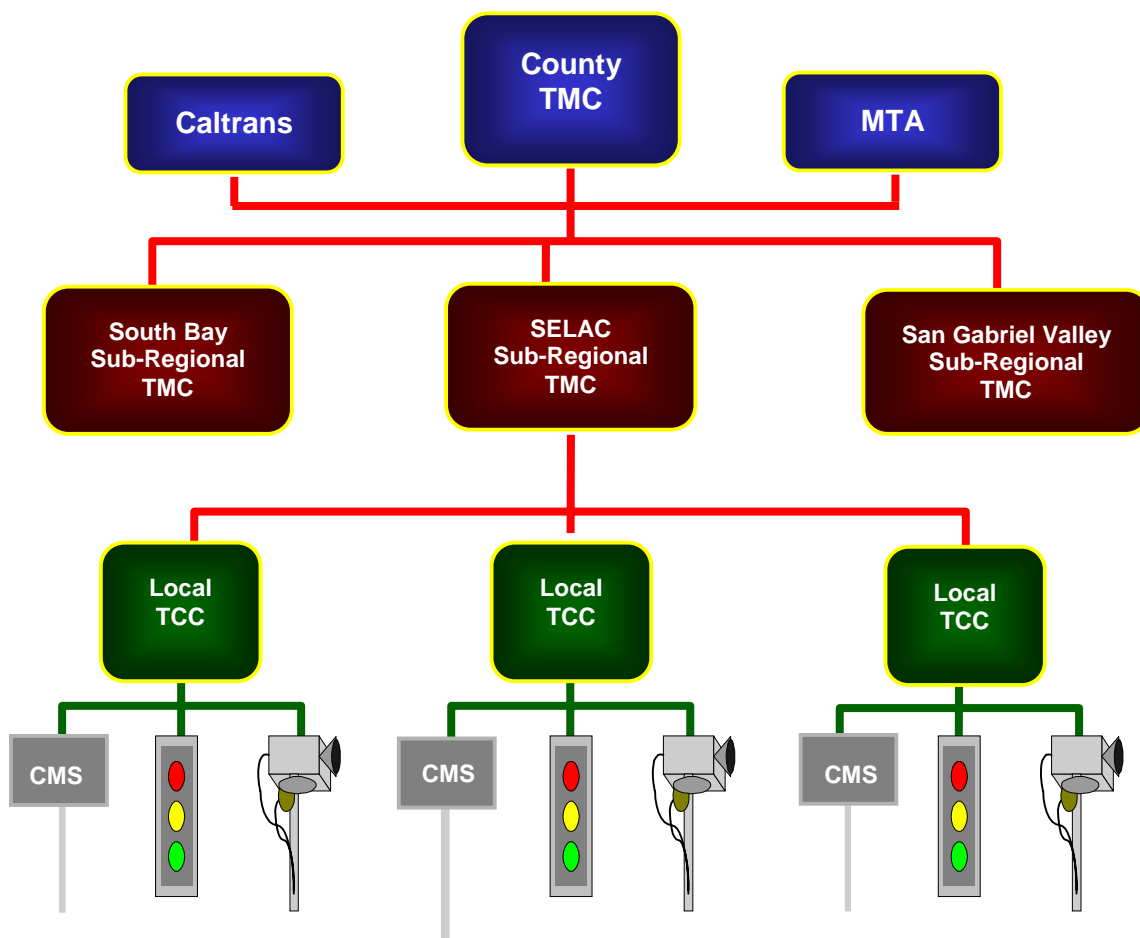
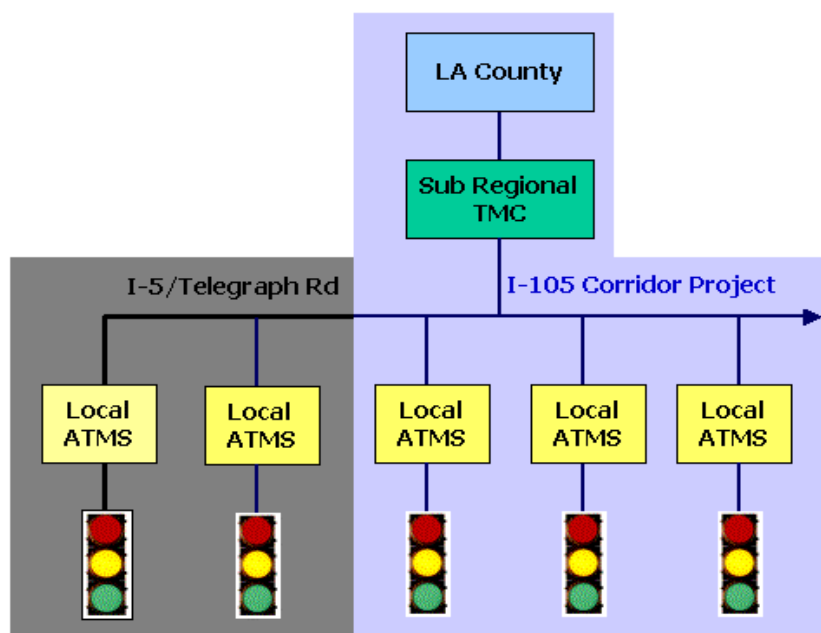


Figure 2.1: System Concept

It is envisioned that the Sub-Regional TMC will provide two primary functions:

- The Sub-Regional TMC will act as a clearinghouse for the exchange of data and information between individual agencies, but will have limited or no direct control of field devices (unless otherwise agreed upon by the involved agencies). Instead, direct control of field devices shall be under the jurisdiction of the local/responsible agency.
- The Sub-Regional TMC will provide a central point for the distribution of traveler information on a regional basis. The Sub-Regional TMC shall have direct operating responsibility for traveler information databases, Internet web page servers, telephone response systems, and general broadcast information distribution. Direct operation of field information devices such as CMS shall reside with the local/responsible agency, and center-to-center links will be provided to coordinate operation (subject to agency agreements/understandings).

The relationship between the I-105 Corridor and I-5 Telegraph Road Corridor is shown in Figure 2.2. This emphasizes the role of the I-105 Corridor Project in providing the Sub-Regional and Regional connectivity while the I-5 Telegraph Road Corridor Project addresses the Corridor and local levels along the Telegraph Road Corridor. The resultant integration will allow an added benefit of monitoring corridor-wide traffic patterns, including incidents and special events, and responding to these traffic patterns in ways that ensure safe travel and minimum delays throughout the Corridor.



**Figure 2.2: Relationship Between the I-105 Corridor and I-5 Telegraph Road Projects**

The I-5/Telegraph Road Corridor System will introduce the following operational enhancements:

- Coordinated traffic signal management operations among participating agencies. The overall objective is to distribute demand among all roadways of the Corridor so as to achieve minimum overall delay and optimum system utilization. This is particularly useful in managing incidents where the reduced capacity on one roadway is handled efficiently through increased throughput on other arterials.
- Exchanging traffic information (link volume, occupancy, incidents, delays, etc.) between the local cities, regional agencies, TMC's, and the public. The exchange of information will enable system managers to select proper control strategies and coordinate signals so as to achieve minimum overall delay throughout the entire Corridor. The demand can be controlled through informing the public of traffic conditions and advising them of alternate arterials within the Corridor. This will redistribute the demand proportionately in accordance with available freeway and arterial capacity.
- The ability to respond to Caltrans freeway management system incident data by implementing pre-determined multi-jurisdictional coordinated signal timing.

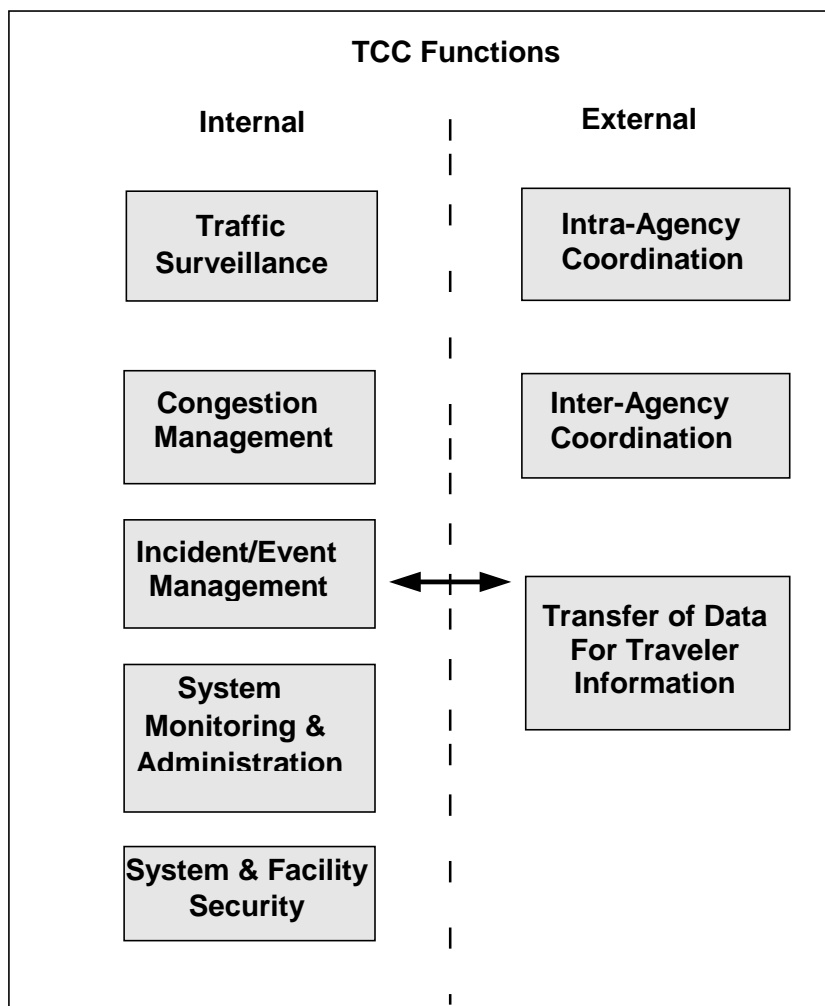
## 2.2 Operational Concepts

The multi-city and agency participation in the CAMS, dictate the consideration of two types of operations centers; a local city traffic control center (TCC) and a Sub-Regional TMC. At this stage of the Project, final decision of the configuration of the Sub-Regional TMC has not been reached. For the purpose of the I-5 Telegraph Road Project, the focus is on the TCC.

The potential functions that could be provided by at such a location can be divided into two categories:

- **Internal Functions.** These are functions that relate to the operation of system components within the jurisdiction of a specific city or agency. Examples include the operation of local traffic signal systems, local congestion, incident and event management using CCTV, system detection, CMS, etc., and the operation of the associated central control, monitoring and communications systems.
- **External Functions.** This includes the exchange of data, information, and/or video with outside users such as other cities, Caltrans, and the general public. The type of data/information exchanged with other agencies typically depends on multi-agency/city agreements and understandings that govern items such as type of data/information exchange, level of access/control, and permissions. For the general public, a key function of the TCC is to provide information to the Sub-Regional TMC about roadway conditions, congestion, incidents, events, etc. The Local TCC may also receive information about signal problems, accidents, and other items from calls by the public.

These functions are illustrated in Figure 2.3 below, and described in the following subsections.



**Figure 2.3: Local TCC Functions**

### 2.2.1 Internal TMC Functions

**Traffic Surveillance:** This involves the real time monitoring of traffic parameters such as volume, occupancy, and speed collected by system detectors and closed circuit television cameras. Monitoring of the system detectors is typically done as an automated process, with alarms being activated to notify traffic-engineering staff of unusual conditions at an intersection or along a segment of roadway. In some cases, the system detector information may be used to automatically implement a system response, with or without operator intervention per the policies of the agency (traffic responsive operation). Collected data is aggregated and stored for later analysis. This data may be exported to off-line programs used in the generation and optimization or traffic signal timing plans.

Closed circuit television allows operators at the Local TCC to verify traffic patterns at intersections, roadway segments, or other critical locations, primarily to verify conditions or assess the impacts of implementing a system response. Facilities at the Local TCC for

providing CCTV monitoring may include dedicated television monitors, a large screen projection TV, or windowed video on a computer workstation.

**Congestion Management:** This is an operational activity designed to enhance traffic responsive operation to address traffic congestion. Recurring congestion patterns are detected in real time and can generally be predicted based on historical experience. Tools are provided to allow the development and implementation of traffic control strategies to reduce and disperse congestion. Such strategies can run counter to free-flow, traffic responsive type operation.

**Incident/Event Management:** This refers to traffic response plans that are implemented to manage traffic during an accident, incident (e.g. hazardous material spill, natural flood or earthquake), planned lane closure, or special event such as parade or stadium event. These events occur irregularly, and may create non-recurring congestion. Some are predictable and can be prepared for by creating a custom response plan. Others occur without warning, and may require use of the closest suitable existing plan, or dynamic creation of a new plan.

**System Monitoring and Administration:** The Local TCC typically provides central (automated) monitoring of the status of all field devices that communicate with a central computer. Status information is used to confirm that a device is working correctly (e.g. a detector loop is on line, a changeable message sign is showing the correct message), and to detect system faults and alarms. Maintenance and performance logs are generated, and maintenance staff may be dispatched in response to a system problem (manually or automatically). Tools may be provided for the on-line analysis of signal timings (split, cycle and offset).

Normal system administration functions such as central computer maintenance and software updates, changes in security and access, etc. are also performed through workstations at the Local TCC. For centrally controlled signal systems, new timing parameters or plans are generated at the Local TCC and downloaded to the field. Software updates for field devices may also be downloaded from the Local TCC, but more typically they require field PROM changes or direct connection with a laptop computer.

**Security:** There are two types of security relevant to the system and its environment:

1. **System security** that establishes access privileges for operational staff, and detects any system breaches. There are different options for providing system security ranging from individual levels of password access for different users, through establishing “roles” for categories of users such as the “system administrator”, “operator”, etc. In the latter case, passwords are used to identify a specific user, but each user has similar privileges as others in that category.
2. **Facility security** controls who has access to the Local TCC building/rooms, and detects physical breaches, intrusion, or vandalism. A Local TCC typically has a number of critical spaces including a control room, communications room, and computer room. Access to each is sometimes individually controlled.

## 2.2.2 External TMC Functions

**Intra-Agency Coordination:** The traffic engineering department of an agency typically works closely with other internal departments such as public works, planning, maintenance and emergency services. Public works may provide input on planned roadway construction activity,



unplanned events such as a water main break, and other information related to the street and utility infrastructure. Operations staff uses this information to update or create new response plans. In return, the public works department may be advised of infrastructure-related problems detected by the Local TCC.

System detector data provides a valuable source of traffic information for planning departments. Long term changes in urban development, and the street network, etc. impacts response plans and potentially the configuration/operation of field devices.

Maintenance staff may or may not be co-located at the Local TCC (more typically they are off-site at a maintenance yard or other location). An important function of the control site is to advise maintenance staff of field device malfunctions or routine maintenance functions. This may be pre-scheduled and/or the control site may have a direct dispatch facility.

Subject to the policies of the agency, there are typically links to local police, fire and other emergency services for the purpose of detecting and responding to incidents or events. Incidents detected by the system can be reported to emergency services, and they (particularly the police) may report accidents or other problems that impact traffic to the Local TCC.

For smaller agencies, the link with emergency services is usually by telephone or intercom. Larger TMC's (e.g. Caltrans District 7) may include an officer co-located in their Local TMC facility.

**Inter-Agency Coordination:** A key function of the Local TCC is to facilitate coordination with other agencies through the exchange of data and information. Data will flow between local city TMC's, Sub-Regional TMC and County TMC. Rules for the sharing of data and information may be created on a bi-party basis, or through group agreement (or Memorandum Of Understanding) depending on the organizational structure and policies of the participating agencies. The following illustrates the kind of information that may be shared between agencies, but is not intended as a recommendation or as a statement of policy. Specific rules and permissions for information sharing will need to be developed by the participating agencies as the Project progresses.

Possible types of information sharing include:

- Exchange of signal timing and other response plans to facilitate coordination at jurisdictional boundaries, or along major arterials that cross multiple jurisdictions.
- Real-time exchange of system detector data to allow one agency to implement local timing and response plans in response to changing traffic conditions in an adjacent jurisdiction.
- Sharing of CCTV video images, potentially with access control to manage who has access to what images and under what conditions.

There is also the potential to share control of field devices within a Sub-Region covered by two or more agencies for the purpose of implementing regional responses, or to allow one agency to use the pan-tilt-zoom features of another's CCTV system. Special agreements are usually required to allow this type of access, and may be subject to various operational restrictions such as time of day/hours of operation, traffic conditions, special events, etc.

**Transfer of Data for Traveler Information:** The Local ATMS collects traffic data such as volume and occupancy from field devices, aggregates the data and deduces congestion

parameters such as travel times and speeds. These parameters provide a measure of mobility status on roadways which can be a useful part of an ATIS system. Effectiveness of an ATIS system increases with area of coverage both geographically and across different modes. For this reason the traveler information function is typically performed at the Sub-Regional TMC or Regional TMC level where data from local TCC's is aggregated. Hence, the Local TCC's provide the data to the Sub-Regional and/or Regional TMC.

## 3.0 USER REQUIREMENTS

The User Requirements specify the capabilities of the system from the user's operational standpoint. The purpose of these requirements is to generate a common understanding of the system for both the user community as well as the developers of the system. The majority of Users' Needs identified by the I-105 Corridor agencies are parallel to the ones in San Gabriel Valley Pilot Project (SGVPP). The I-5 Telegraph Road exercise has refined and enhanced the requirements previously derived during the foregoing projects.

### 3.1 Advanced Traffic Management System ATMS

In the following statements, "the system" and "ATMS" are interchangeable. The following sub-sections identify the key functional requirements for achieving traffic signal synchronization within the Project area. The sub-sections below present the key requirements in the following categories:

- System Philosophy
- Inter-Jurisdictional Coordination
- Agencies Involved
- Local Cities Involved
- System Architecture
- Data Collection
- User Interface
- System Control
- System Status
- Map Display and Real-Time Displays
- Report Generation
- Event Logs
- Database Editing
- System Security
- Incident Management

#### 3.1.1 System Philosophy

- |         |  |
|---------|--|
| UR TS.1 | ATMS will implement a download/plan select, distributed control philosophy (The term distributed control philosophy refers to current established practice of plans being developed and stored centrally, and implemented locally after being downloaded to the controller – this allows the system to be less susceptible to communications errors) |
| UR TS.2 | Time bases in each ATMS shall be synchronized  |
| UR TS.3 | The time reference clocks of each local ATMS shall be synchronized with the entire system to enable area-wide coordination   |

## 3.1.2 Inter-Jurisdictional Coordination

- UR TS.4 The system shall provide seamless traffic flow between jurisdictions
- UR TS.5 ATMS shall provide inter-agency plan selection capability
- UR TS.6 The system shall be capable of corridor wide monitoring and traffic conditions
- UR TS.7 One agency will be able to request/implement plan changes in other agencies to accommodate emergency operations and/or non-recurrent congestion situations
- UR TS.8 Each agency's ATMS shall have the ability to reference plans and traffic conditions in the Corridor

## 3.1.3 Agencies Involved

Traditionally traffic control systems have collected parameters such as volume, occupancy and speeds. These individual parameters do not provide a good indication of mobility through the network. Combining these parameters to get a measure of congestion such as travel times or speeds provides a better indication of network performance. The I-5 Agencies want to focus their operations at places where there are traffic problems effecting mobility and, hence, have requested that the local ATMS should be capable of providing congestion monitoring with associated alarms.

### LA County Department of Public Works (LACDPW)

- UR TS.9 LACDPW shall have operational control of signals within its jurisdiction
- UR TS.10 LACDPW shall be able to perform operational monitoring (refers to phase displays and real time plan data) of all signals in the region
- UR TS.11 LACDPW shall be able to perform functional monitoring (refers to alarms and faults) of all signals that it maintains

### Caltrans

- UR TS.12 Caltrans shall have operational control of arterial signals within its jurisdiction
- UR TS.13 Caltrans shall be able to perform operational monitoring of arterial signals in the region

### LACMTA

- UR TS.14 LACMTA shall be able to perform operational monitoring of arterial signals in the region

## 3.1.4 Local Cities Involved

- UR TS.15 Local cities shall have operational control of signals within their jurisdictions
- UR TS.16 Local cities shall be able to monitor all signals within their jurisdictions
- UR TS.17 Local cities shall be able to monitor the operation of signals corridor wide
- UR TS.18 Local cities shall be able to perform functional monitoring of controllers for maintenance purpose
- UR TS.19 Local cities shall be able to redirect control to alternate agencies

## 3.1.5 System Architecture

- UR TS.20 The ATMS shall be consistent with the County's IEN Architecture
- UR TS.21 The ATMS shall be consistent with the National ITS Architecture
- UR TS.22 The system shall be modular and scaleable
- UR TS.23 ATMS hardware shall have networking capability
- UR TS.24 The ATMS shall be based upon a client-server architecture
- UR TS.25 Industry standard processors and network components shall be used

## 3.1.6 Control Modes

The system shall support the following modes of operation:

- UR TS.26 Central Coordinated: The controllers operate according to a pre-determined coordinated timing plan schedule which is stored in the central database
- UR TS.27 Local Coordinated: The controllers operate according to a pre-determined coordinated timing plan schedule which is stored locally in the individual controllers
- UR TS.28 Local Isolated (Free operation): The controller is not being commanded for on-line operation by a Master System
- UR TS.29 Manual: The controller responds to system commands for plan selection issued from the central control using manual override
- UR TS.30 Traffic responsive: The controller responds to system commands for plan selection issued from the central control based on the traffic-responsive algorithm
- UR TS.31 Flashing: The controller is put on flash either manually by the central or at the cabinet. This also includes tripped conflict monitor at the local intersection
- UR TS.32 Pre-empted: The controller is pre-empted by an external system to provide priority to fire or police vehicles

## 3.1.7 Data Collection

- UR TS.33 The ATMS shall provide the capability of collecting and maintaining all data required for monitoring, and confirmation of displays from all intersections concurrently
- UR TS.34 If the intersection is not running coordinated, data shall continue to be collected
- UR TS.35 The ATMS shall monitor intersection operation to verify compliance with the selected timing plan (Real-Time Data Monitoring)
- UR TS.36 ATMS will be capable of exporting signal timing and volume information for off-line timing generation (Off-Line Timing Generation)
- UR TS.37 The ATMS shall synchronize ATMS clocks based on an external, universal time reference time
- UR TS.38 Data collected by the ATMS shall be capable of being aggregated to peak hour volume as used to satisfy the LACMTA Congestion Management Plan highway monitoring requirements

## 3.1.8 User Interface

- UR TS.39 All user accessible software shall use a Graphical User Interface (GUI)
- UR TS.40 The GUI shall allow the use of a mouse
- UR TS.41 The GUI shall provide users with drop-down menus for commands to the system
- UR TS.42 The GUI shall provide context-sensitive on-line help

## 3.1.9 System Control

- UR TS.43 Operators will be able to manipulate intersection controllers if they have the proper privileges
- UR TS.44 Local agencies will be able to delegate control authority to another agency
- UR TS.45 Operator shall be able to log in from a remote location and be able to operate the system

## 3.1.10 System Status

- UR TS.46 The ATMS shall display status of system controllers
- UR TS.47 The ATMS shall log and alarm equipment faults and errors
- UR TS.48 The ATMS shall report events which are not faults or errors such as a cabinet door is open

## 3.1.11 Map Display & Real-time Displays

- UR TS.49 The user interface shall provide geographically accurate maps in the Project region
- UR TS.50 Users shall be able to zoom and pan maps to provide more detail views, through the use of a mouse
- UR TS.51 ATMS maps will allow the display of arterial incidents
- UR TS.52 Operators with proper access level shall be able to edit maps

## 3.1.12 Report Generation

- UR TS.53 The system shall be capable of generating maintenance reports
- UR TS.54 ATMS shall be capable of automatically generating reports via time-of-day scheduling

## 3.1.13 Logging

- UR TS.55 The system shall record actions taken and changes of status
- UR TS.56 The system shall record operator actions in a system log
- UR TS.57 The operator shall be able to add comments to the system event log
- UR TS.58 The ATMS shall record when timing plan changes have occurred

## 3.1.14 Database Editing

- UR TS.59 The system shall provide mechanisms for auto-upload, auto-download and auto-compare
- UR TS.60 The system shall provide on-screen display and editing of controller parameters

UR TS.61 The system shall be capable of printing reports

## 3.1.15 System Security

UR TS.62 Local agencies shall retain control authority

UR TS.63 ATMS shall recognize groups of operators to which access privileges are allocated

UR TS.64 ATMS shall have different access levels

UR TS.65 Access levels shall control access to functions

UR TS.66 Access levels shall control access to equipment

UR TS.67 The system shall allow multiple simultaneous operators to monitor controller behavior

## 3.1.16 Interface to the IEN

UR TS.68 The ATMS shall support an interface according to the Information Exchange Network standards

## 3.1.17 CAMS Requirements

UR TS.69 The ATMS shall provide the functionality required to support the requirements of the Countywide Arterial Management System

## 3.2 **Detection System**

An intersection can have several different types of detection components. Their purpose dictates the location of detection devices. Basic vehicle actuation of the intersection requires detectors at the stop bar to enable a vehicle to call for service. They are also used to confirm the need for continuing green display to that approach. Advanced detectors are also used for this purpose. Their placement is on the approach to the intersection but farther from the stop-bar and improves the efficiency of operation of the intersection.

System detectors are not used for direct intersection control, but for the collection of traffic data to enable a broader view of the network conditions to be taken into account in selecting signal timings. These devices collect volume and occupancy data per each lane. Typically, system detectors need to be located where there is little chance of traffic conditions affecting the operation of the detectors (e.g. to avoid queuing over a loop detector, loops are located 250' to 300' from the stop-bar).

The detection system User Requirements have been divided into following three categories based on the inputs received from the I-5/Telegraph Road Corridor agencies and subsequent interviews with the individual agencies.

**Data:** Addresses what, where and for what purpose data should be collected.

**Technology:** Addresses features to be supported by the chosen detection technology.

**Inter-Agency Operation:** Addresses requirements related to sharing of detector data among agencies.

The following lists represent the User Requirements for the detection system for the I-5/Telegraph Road Corridor Project.

## 3.2.1 Data

- UR TS.70 At a minimum, per lane volume and occupancy between all major intersections (mid-block) shall be collected
- UR TS.71 Above data will be used for planning purpose, timing plan generation, and as input into incident detection and adaptive traffic control algorithms

## 3.2.2 Technology

- UR TS.72 Detection technology shall be reliable and provide accurate data on a per lane basis
- UR TS.73 Detection technology shall be cost-effective on a life-cycle basis
- UR TS.74 Detection technology may be permanent or temporary
- UR TS.75 Detection technology shall perform in all weather conditions

## 3.2.3 Inter-Agency Operation

- UR TS.76 It shall be possible to share real-time detector data (at a minimum, volume, occupancy, and speed) among various jurisdictions in I-5/Telegraph Road Corridor

## 3.3 **Requirements Specific to the I-5/Telegraph Road Corridor Agencies**

### 3.3.1 Additional Requirements

#### Staffing and Training

- UR TS.77 Operation of a new ATMS shall not require staff dedicated to operations
- UR TS.78 Agency traffic engineering staff should be capable of being trained to operate the system

#### Cost

- UR TS.79 ATMS computer equipment shall be capable of being maintained by the agency's IT staff
- UR TS.80 ATMS Commercial off the Shelf Software (COTS) shall not require obligatory maintenance contracts
- UR TS.81 COTS hardware and software shall be used wherever possible
- UR TS.82 Custom and proprietary hardware and software solutions shall be avoided wherever possible

### 3.3.2 Agency Specific

#### City of Commerce

- UR TS.83 The ATMS shall permit the selection of Caltrans cameras for viewing only
- UR TS.84 The ATMS shall recognize a police operator
- UR TS.85 The ATMS shall allow police operator to monitor equipment
- UR TS.86 The ATMS shall allow police operator to log event information



- UR TS.87 The system shall report congestion by aggregating raw volume and occupancy data collected from one or more intersections to derive measure such as travel time and speeds

## City of Downey

- UR TS.88 The ATMS shall permit the control of CCTV cameras
- UR TS.89 The ATMS shall permit the viewing of video images from the CCTV cameras
- UR TS.90 The ATMS shall allow operator to manage incidents on the City arterials
- UR TS.91 The ATMS should interface to SYNCHRO
- UR TS.92 The system shall report congestion

## City of La Mirada

- UR TS.93 The ATMS shall permit a County operator to operate the City's signals
- UR TS.94 The system shall report congestion
- UR TS.95 The ATMS shall support remote display functions

## City of Santa Fe Springs

- UR TS.96 The system shall be able to implement control strategies to mitigate against rail crossing closures
- UR TS.97 The system shall support Econolite controllers
- UR TS.98 The system shall respond to freeway incidents in an automated fashion by triggering a pre-defined response (such as timing plan changes and/or CMS message deployment)
- UR TS.99 The system shall accommodate transit priority
- UR TS.100 The system shall accommodate emergency vehicle pre-emption
- UR TS.101 The system shall incorporate above-surface detection
- UR TS.102 The system shall support dynamic message signs

## 4.0 USE CASE ANALYSIS

As described in Section 3, the User Requirements specify the capabilities of the system in terms that a user can understand. The Use Case analysis, on the other hand, captures users' expectations of the functionality of the system and expresses them clearly in terms that system developers can follow. The Use Case model, which expresses top-level Functional Requirements, is the central part of a Requirements Document for the object-oriented development approach<sup>1</sup>.

The Use Case model emphasizes interfaces and end-to-end functionality within the "system" by systematically identifying all "system users" and actions they might take. Each "User Case" describes how a "System User" or an "actor" would use the system in each particular "Case". That is, each Use Case describes a particular and observable system behavior. These "behaviors" can be traced back to each identified User Requirement in Section 3. These statements must be easily understood by end users (I-5/Telegraph Road Corridor agencies) and system developers.

The following initial Use Cases are intended to be informal, and will become better defined and more complete through an iterative review process. This document does not intend to explore the Use Case model and analysis in great details.

### 4.1 System Users

Use Cases are guaranteed to be observable by the fact that they must be connected to one or more "actors". In the I-5/Telegraph Road Corridor System, actors (system users) are the ones who operate various levels of traffic control systems; contribute, access and manipulate traffic data; and disseminate relevant traffic information to other agencies or public motorists. Multiple agencies will be able to coordinate their traffic signals, share real-time traffic information, respond to the Caltrans freeway management system and ultimately improve travel speeds along the arterial.

System User/Use Case Actor	Description
Caltrans Freeway System	Caltrans computer system that manages freeway data. It provides selected data to outside agencies through a defined interface.
Sub Regional Operator	A system operator who is responsible for managing the Sub-Region. The Sub-Regional Operator function is normally performed at the Sub-Regional TMC, but operators at other locations may also assume this role.
County Operator	An operator who is responsible for monitoring congestion and traffic signal operations across the entire County (the entire system). The County operator function is normally performed at the County TMC, but operators at other locations may also assume this role.

<sup>1</sup>"Developing Object-Oriented Software - An Experience-Based Approach", By Kenneth S. Rubin, IBM Object-Oriented Technology Center, 1997.

System User/Use Case Actor	Description
External ATMS	An ATMS (Traffic Signal Management And Control System) which is not part of nor directly compatible with the I-5/Telegraph Road Corridor System.
Field Technician	Technical person within signals group who can make physical repairs to the signals and network hardware.
Intersection Controller	The Intersection Controller is the interface from the overall system to the vehicles on the street.
Local Operator	The Local Operator function is normally performed at a local agency TMC, but operators at other locations can assume this role if they have the correct security access privileges. Note County also acts as a local operator.
Maintenance Operator	An operator responsible for monitoring the system for equipment problems.
Off-Line Operator	The Off-Line Operator function is usually performed by a Traffic Engineer and can be performed from any workstation on the network.
System Operator	The system operator manages the system for others use. This operator sets up users accounts, equipment configuration, and so forth.
Vehicle Detector	The Vehicle Detector is the system's primary input from the street. Vehicle Detectors include, but not limited to, inductive loops or video detectors.
WWV Clock	The WWV Clock object is the system's interface to a WWV time reference. It provides accurate time information to permit time-based traffic signal coordination between geographically separated intersections within the system.

## 4.2 Use Cases

The following "cases" intend to capture every type of interaction that the system will have with the "outside" world, based on the User Requirements. These "cases" do not represent the design of the I-5/Telegraph Road Corridor ATMS system. They only describe the interfaces to the system and are used to verify that all requirements for the system have been identified, and all identified requirements have been addressed. The objects identified in the Use Case analysis will be carried forward to subsequent steps of the object-oriented design process.

## 4.2.1 Control Traffic

Controlling traffic consists of determining what plan to run, what mode to run the controller in, implementing it via communications, and verifying its correct operation via communications.

## 4.2.2 Operate Signals

The Local Operator is responsible for operating all traffic signals within the local agency's jurisdiction, such as manually changing timing plans on control modes.

## 4.2.3 Monitor Signals

The Local Operator monitors signal operation and congestion within the local agency's jurisdiction using status screens, maps and alarms.

## 4.2.4 Maintain Signals

The Local Operator receives maintenance events and alarms for signals within the local agency's jurisdiction, for purposes of maintaining correct operation of the signals. The Local Operator may make database adjustments or dispatch field technicians in order to correct the problems detected.

## 4.2.5 Synchronize Clocks

The computers in the system synchronize all their clocks to one or more WWV Clocks.

## 4.2.6 Generate Timing Plans

Off-Line Operator creates and edits timing plans and schedules in order to optimize traffic flow through the system.

## 4.2.7 Manage Timing Plans

The Local or Off-Line Operator can edit signal timing plans and schedules for controllers in the local agency's jurisdiction in order to optimize flow.

## 4.2.8 Schedule Operations

The Off-Line Operator sets up scheduled plan changes and other time-of-day operations.

## 4.2.9 Exchange Coordination Data

External ATMS system exchanges coordinated information with the system through a Control/Data Interface (CDI). Data exchanged includes equipment status, operating modes, traffic levels, events, and plan implementation commands.

## 4.2.10 Data Archiving

The System stores data regularly for off-line analysis including documenting system performance.

## 4.2.11 Monitor Congestion

The system monitors congestion and reports it to the Local, Sub-Regional or County Operator via status screens, maps and alarms.

## 4.2.12 Analyze Data

The Local Operator or Off-Line Operator can record, review and analyze signal timings and traffic data.

## 4.2.13 Measure Traffic

Vehicle detectors provide data (e.g. volume and occupancy) to the system. Other parameters or MOES (e.g. vehicle speed, stops, delays, queue length) are calculated by the system based on the collected data.

## 4.2.14 Monitor Events and Alarms

The Maintenance Operator receives maintenance events and alarms for the system or signals within the local agency's jurisdiction for purposes of maintaining correct operation of the signals. The Maintenance Operator dispatches field technicians or contacts a System Operator in order to correct the detected problem.

## 4.2.15 Generate Maintenance Log Reports

The Maintenance Operator can generate reports of historical data from the logs of events and alarms.

## 4.2.16 Log Event Details

The system logs events. The Maintenance Operator may enter additional details of field events into the event log database, which will appear when system maintenance reports are printed.

## 4.2.17 Repair Equipment

The Field Technician is responsible for correcting or repairing problems that occur with field hardware. When the repair is complete the technician notifies the system or a local operator that the equipment is operational. If a controller was replaced in the field, then the technician may request a download of timing sheet data to the controller.

## 4.2.18 Configure Operations

The Off-Line Operator configures all traffic control aspects of the system, such as intersection, detector, and group geometry, traffic responsive operation, and connections to traffic data from other jurisdictions.

## 4.2.19 Configure System

The System Operator manages hardware and software configuration issues, such as file and directory location, database backup and replication and jurisdictional partitioning.

## 4.2.20 Manage Network

The System Operator performs overall network management on the Local Area Network (LANs) in the system using COTS software packages. Different System Operators may have responsibilities for different paths of the physical network.

## 4.2.21 Manage Resources

The System Operator manages access to system resources. This includes setting the rights or privileges necessary to access a resource, and resolving dynamic conflicts involving resource locking.

## 4.2.22 Manage Users

The System Operator adds, modifies, and deletes authorized users and the privileges assigned to each of them.

## 4.3 The Use Case Diagram

Having defining the actors and the Use Cases, it is now possible to relate them together. This is illustrated in Figure 4.1, the Common ATMS Use Case Diagram, which depicts those Use Cases which have been identified as common to all ATMS.

Figures 4.2 through 4.4 show additional Use Cases derived from the interviews with the agencies in the I-5/Telegraph Road Corridor. These are described in the following Sections.

Note that in Figure 4.2, a new Operator has been defined for the City of Commerce – that of Police Operator.

### 4.3.1 View CCTV Image

The Operator can select a camera and view its image on the ATMS workstation. This may also involve control of the camera movement (pan, tilt and zoom) and selection of monitor or display device other than the ATMS workstation.

### 4.3.2 Control City Camera

The ATMS can control the movement of a CCTV camera within the agency's jurisdiction.

### 4.3.3 Select Caltrans Camera

The ATMS can request a CCTV image from the Caltrans CCTV system for display on ATMS workstations.

### 4.3.4 Manage Signs

This comprises the management and monitoring of dynamic message signs. This involves the composition of messages, downloading of messages to the sign and determination of messages to be shown.

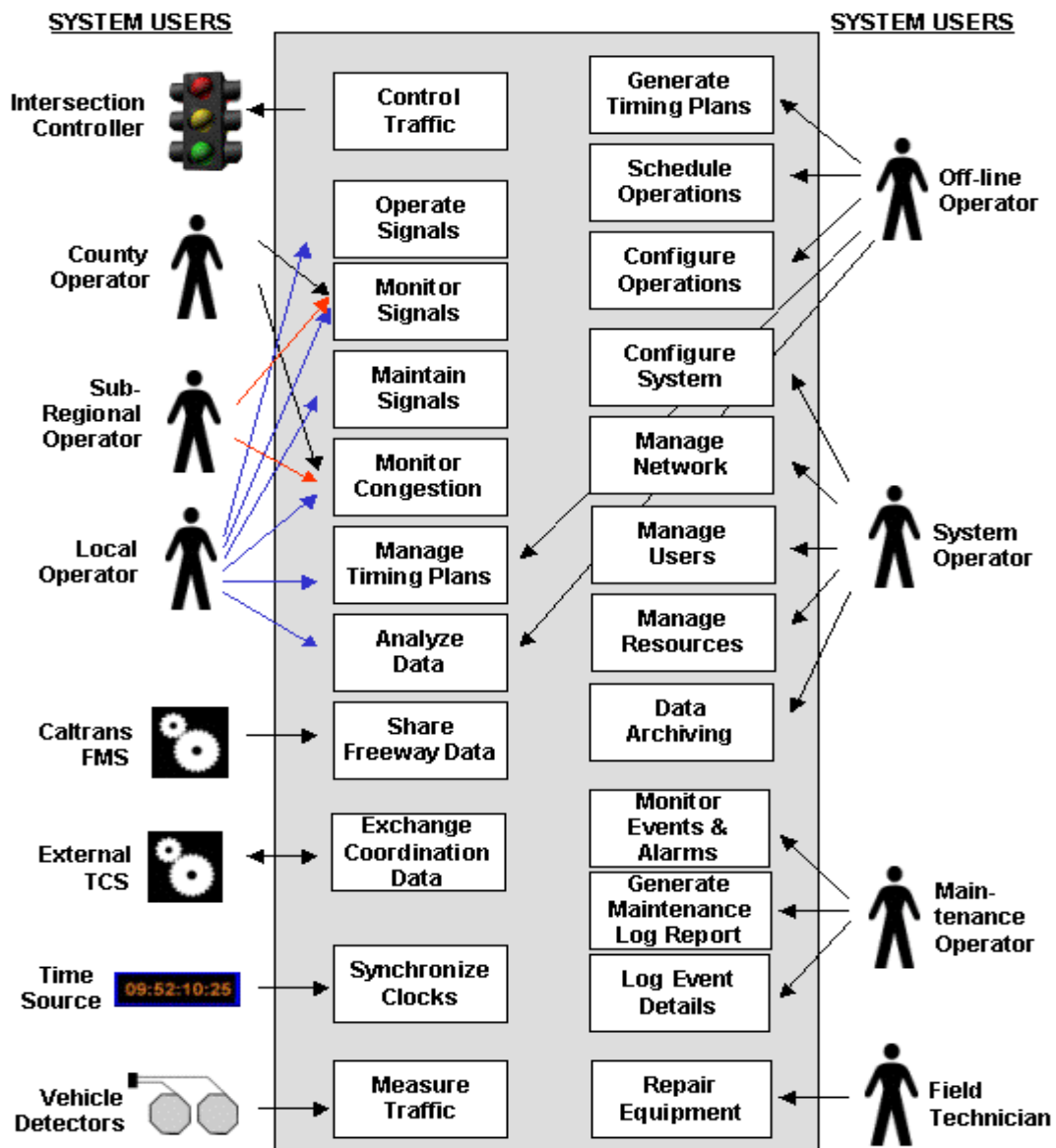
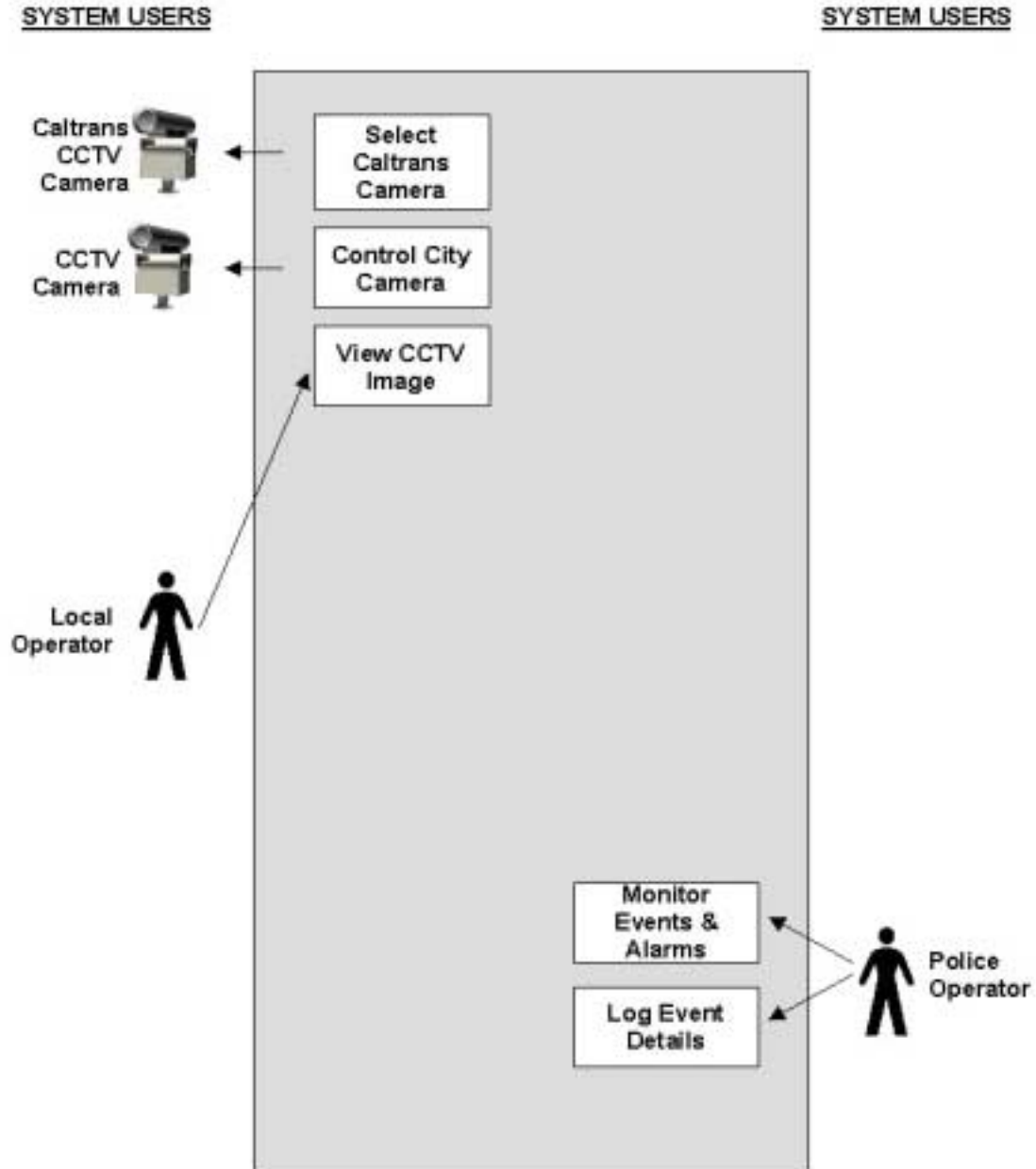
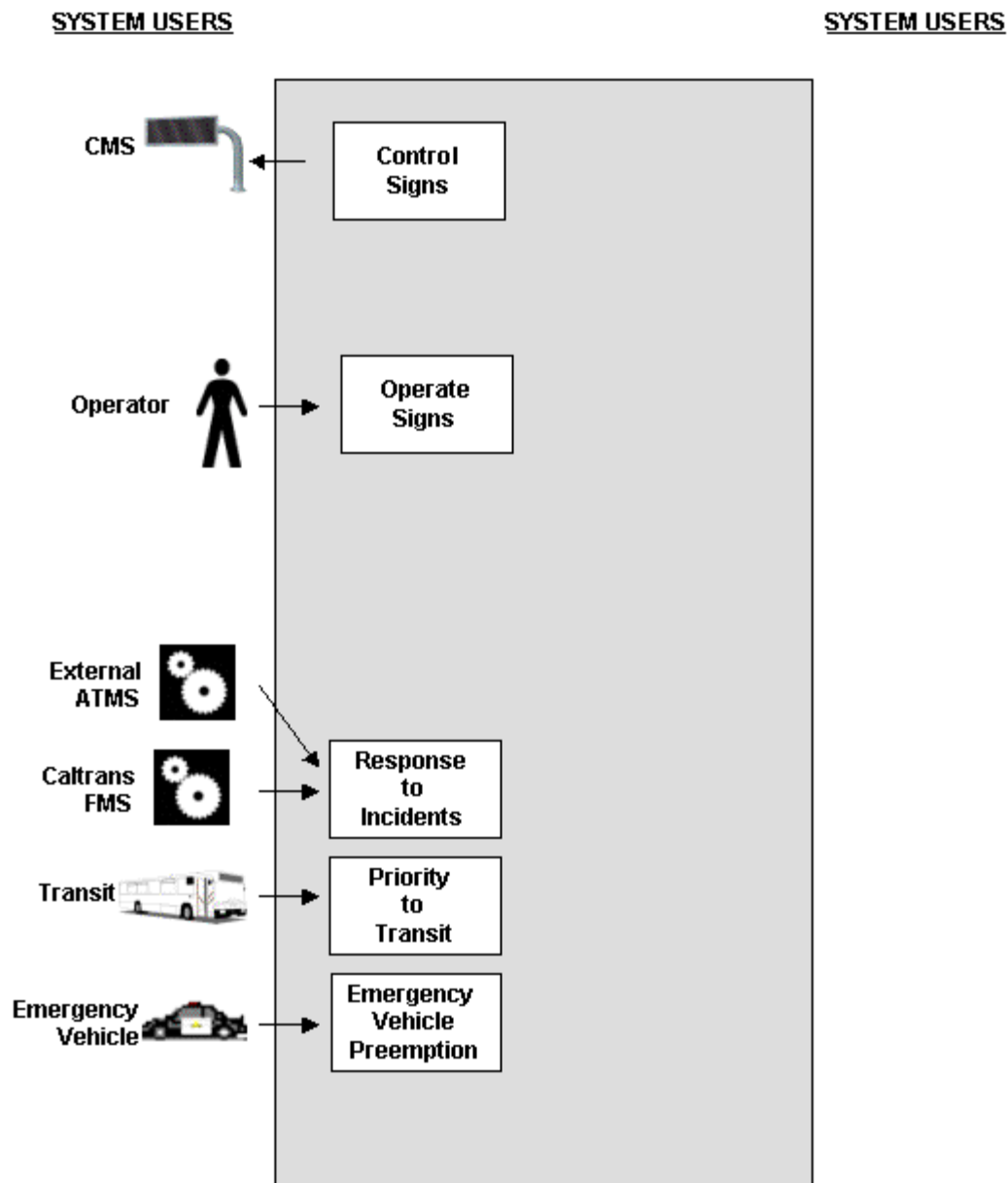


Figure 4.1: Common ATMS Use Cases

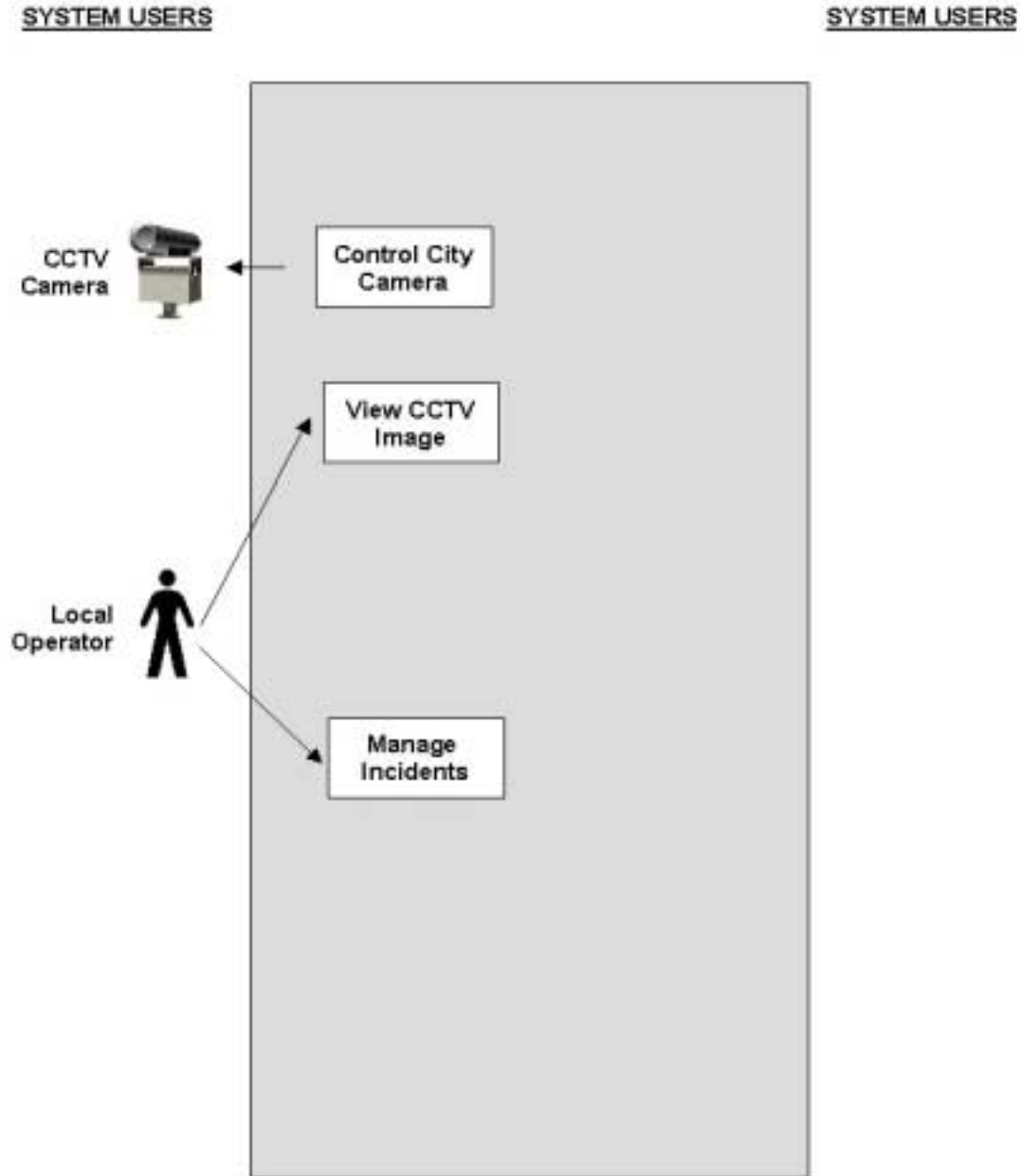


**Figure 4.2: Additional Use Cases – City of Commerce**





**Figure 4.3: Additional Use Cases – City of Santa Fe Springs**



**Figure 4.4: Additional Use Cases – City of Downey**

## 4.3.5 Control Signs

This comprises the control of the sign for the selection of messages to be displayed and monitoring of the sign for correct operation.

## 4.3.6 Response to Incidents

The ATMS can respond to incidents on the freeways and so mitigate the impact on the arterials adjacent to the affected freeway. The ATMS can also respond to incidents on arterials to mitigate their impact. This includes the development and implementation of suitable traffic management strategies.

## 4.3.7 Priority to Transit

The ATMS can accommodate the modification of signal timings so as to give preferential treatment to transit vehicles in the network. This involves detection of the bus, determination of need for priority, implementation of the chosen control strategy (e.g. modifications of phasing or timing), monitoring of the action and removal of the priority treatment.

## 4.3.8 Pre-Emption to Emergency Vehicles

The ATMS can accommodate the pre-emption of signal timings so as to give preferential treatment to emergency vehicles in the network.

## 4.3.9 Manage Incidents

Having detected an incident in the network, or having been notified of an incident (such as a special event), this provides the Operator with tools to monitor the incident, record changes in status, and implement suitable mitigation actions. This may also include automated up-dates of the status of the incident based on data from external sources.

## 4.4 **Use Cases and the User Requirements**

The final step in the current analysis is to set the stage for the further derivation of more detailed requirements from the Use Cases in the following stages of the Project. This involves relating the User Requirements to the Use Cases. This is further explained and documented in Section 5 of this report.

## 5.0 REQUIREMENTS TRACEABILITY

### 5.1 Requirements Management Process

Requirements Management is a systematic approach to finding, organizing, documenting and tracking the requirements of a system. To promote Project success, an effective requirements management process is a necessity. This process offers numerous benefits to the Project, including improved predictability of a project's schedules and deliverables, improved budget adherence, improved quality, and improved team communications.

There are several key elements to the requirements management process. The first is the concept of requirements layering. This involves the creation of different levels of the requirements documentation where each new level builds on the foundation of earlier levels. The second element is the implementation of a requirements traceability matrix. The purpose of this matrix is to systematically map each requirement through to the design of the system, and ultimately into the testing of the system. The third element is the creation of requirements tracking process. This refers to the methodology used to capture, store, and maintain the requirements throughout the life of the Project.

### 5.2 Requirements Layering

Requirements for the I-5/Telegraph Road Corridor Project will be documented in various Project deliverables including the User Requirements document and the Functional Requirements document. The purpose of each document is to specify the capabilities of the system at a particular level of detail.

The User Requirements document represents the first layer of requirements for the I-5/Telegraph Road Corridor System. The User Requirements document specifies the capabilities of the system in terms a user can understand. The purpose of these requirements is to generate a common understanding of the system for both the user community as well as the developers of the system.

The Functional Requirements document represents the second layer of requirements for the I-5/Telegraph Road Corridor System and derives the required to implement the capabilities identified in the User Requirements document. The purpose of these Functional Requirements is to link the User Requirements into the first level of system architecture. The Functional Requirements will take the Use Cases and User Requirements and break them out in further detail. This will also address the Use Cases that were not identified by the I-5/Telegraph Road agencies but were included in the San Gabriel Valley Pilot Project. In addition, the Functional Requirements will also explore the applicability of current ITS standards to the I-5/Telegraph Road Project.

### 5.3 Requirements Traceability Matrix

Once the system requirements are composed, they are entered into a Requirements Traceability Matrix (RTM). An RTM is a matrix that contains the set of requirements for the system. Here the requirements are analyzed and categorized. The RTM allows the user, developer and tester to track the requirements throughout the development of the system. The RTM is based on a requirements repository which consists of a word processor and a database. The database provides traceability between each layer of

requirements of the system. A single User Requirement might generate several system requirements. The RTM provides traceability into the testing of the system, so that it will be possible to verify all system requirements for the I-5/Telegraph Road Corridor System will be properly tested.

The RTM will guide the users, developers, and testers throughout the development of the I-5/Telegraph Road Corridor System. It will provide insight to the users as to how each of the requirements for the system will be satisfied. It also allows the developers to map the requirements into each of the various components of the system in order to clarify the specific purpose for the component. Further, the RTM will enable the acceptance testers to determine whether the implemented system adheres to the I-5/Telegraph Road Corridor System requirements.

## 5.4 Requirements Tracking

Requirements tracking is the methodology by which each of the previous elements of the requirements management process are utilized. During the course of the Project, it is anticipated that the requirements for the I-5/Telegraph Road Corridor System will continue to evolve. This could be caused by many factors, including the possible need for additional system capabilities based on new information, or perhaps the recognition that satisfying a particular requirement is not technically feasible. Another important aspect of the requirements evolution includes the clarification of those requirements that have caused confusion during the Project.

As the requirements for the I-5/Telegraph Road Corridor System are recorded into the database, they are given an identification number that can be used to track the requirements through the life of the Project. As each additional layer of requirements is added to the database, the RTM will identify the relationship between each of the requirements. By utilizing this process, changes to requirements at one layer of the system will allow the development team to automatically identify those requirements at the other layers of the system that are affected. In this way, consistency will be maintained between each of the requirements documents.

The requirements tracking process will be utilized through the design, implementation, and testing phases of the Project. By establishing and maintaining a relationship between the requirements, design, implementation, and test plans for the system, the impact of any changes to the requirements can be immediately identified and assessed. As these changes are entered into the system, the status of the implementation can be readily determined.

An important feature of the requirements tracking process is the baseline concept. As the requirements continue to evolve during the Project, it can become difficult for the development team to maintain a focus on the design of the Project. This is often referred to as the “moving target” syndrome. However, this situation can be alleviated through the establishment of a requirements baseline. By freezing a particular version of the requirements at a particular point in time, a baseline can be established. This baseline gives the development team a concrete definition for the design of the system and eliminates the moving target. Over time, updates to the baseline can be made in coordination with the stakeholders and the development team.

Updates and changes can be made to a requirements document, at the request of a stakeholder or the system integrator, by requesting a requirements modification. The requestor would indicate the proposed changes on a Requirements Modification Request Form. After the form is submitted, the System Developer would evaluate the impact of the modification with respect to cost, schedule and performance. The System Developer would then review and disposition the proposed changes with the client. If the requested requirement modifications are approved, the documents are modified accordingly.

## 5.5 User Requirements to Use Case Mapping

Table 5.1 presents a list of User Requirements generated in the Section 3 and maps them to Use Cases presented in Section 4. Please note that certain requirements are mapped to Use Cases such as “System”, and “Performance”, refer to general system requirements.

**Table 5.1: Requirements Traceability Matrix**

Req. #	Requirement	Use Case
UR TS.1	ATMS will implement a download/plan select, distributed control philosophy.	Control Traffic
UR TS.2	Time bases in each ATMS shall be synchronized.	Synchronize Clocks
UR TS.3	The time reference clocks of each local ATMS shall be synchronized with the entire system to enable area-wide coordination.	Synchronize Clocks
UR TS.4	The system shall provide seamless traffic flow between jurisdictions.	Control Traffic
UR TS.5	ATMS shall provide inter-agency plan selection capability.	Control Traffic
UR TS.6	The system shall be capable of corridor wide monitoring and traffic conditions.	Monitor Signals

Req. #	Requirement	Use Case
UR TS.7	One agency will be able to request/implement plan changes in other agencies to accommodate emergency operations and/or non-recurrent congestion situations.	Manage Timing Plans
UR TS.8	Each agency's ATMS shall have the ability to reference plans and traffic conditions in the Corridor.	Exchanges Coordination Data
UR TS.9	LACDPW shall have operational control of signals within its jurisdiction.	Operate Signals
UR TS.10	LACDPW shall be able to perform operational monitoring (refers to phase displays and real time plan data) of all signals in the region.	Monitor Signals
UR TS.11	LACDPW shall be able to perform functional monitoring (refers to alarms and faults) of all signals that it maintains.	Monitor Signals
UR TS.12	Caltrans shall have operational control of arterial signals within its jurisdiction.	Operate Signals
UR TS.13	Caltrans shall be able to perform operational monitoring of arterial signals in the region.	Monitor Signals
UR TS.14	LACMTA shall be able to perform operational monitoring of arterial signals in the region.	Monitor Signals
UR TS.15	Local cities shall have operational control of signals within their jurisdictions.	Operate Signals

Req. #	Requirement	Use Case
UR TS.16	Local cities shall be able to monitor all signals within their jurisdictions.	Monitor Signals
UR TS.17	Local cities shall be able to monitor the operation of signals Corridor wide.	Monitor Signals
UR TS.18	Local cities shall be able to perform functional monitoring of controllers for maintenance purpose.	Maintain Signals
UR TS.19	Local cities shall be able to redirect control to alternate agencies.	Maintain Signals
UR TS.20	The ATMS shall be consistent with the County's CAMS and IEN Architecture.	System
UR TS.21	The ATMS shall be consistent with the National ITS Architecture.	System
UR TS.22	The system shall be modular and scaleable.	System
UR TS.23	ATMS hardware shall have networking capability.	Performance
UR TS.24	The ATMS shall be based upon a client-server architecture.	System
UR TS.25	Industry standard processors and network components shall be used.	System
UR TS.26	The system shall support the Central Coordinated mode of operation.	Control Traffic
UR TS.27	The system shall support the Local Coordinated mode of operation.	Control Traffic



Req. #	Requirement	Use Case
UR TS.28	The system shall support the Local Isolated (Free operation) mode of operation.	Control Traffic
UR TS.29	The system shall support the Manual mode of operation.	Operate Signals
UR TS.30	The system shall support the Traffic responsive mode of operation.	Control Traffic
UR TS.31	The system shall support the Flashing mode of operation.	Control Traffic
UR TS.32	The system shall support the Pre-Empted mode of operation.	Control Traffic
UR TS.33	The ATMS shall provide the capability of collecting and maintaining all data required for monitoring, and confirmation of displays from all intersections concurrently.	Monitor Signals
UR TS.34	If the intersection is not running coordinated, data shall continue to be collected.	Monitor Signals
UR TS.35	The ATMS shall monitor intersection operation to verify compliance with the selected timing plan. (Real-Time Data Monitoring).	Monitor Signals
UR TS.36	ATMS will be capable of exporting signal timing and volume information for off-line timing generation. (Off-Line Timing Generation).	Generate Timing Plan

Req. #	Requirement	Use Case
UR TS.37	The ATMS shall synchronize ATMS clocks based on an external, universal time reference time.	Synchronize Clocks
UR TS.38	Data collected by the ATMS shall be capable of being aggregated to peak hour volume as used to satisfy the LACMTA Congestion Management Plan highway monitoring requirements.	Data Archiving
UR TS.39	All user accessible software shall use a Graphical User Interface (GUI).	Performance
UR TS.40	The GUI shall allow the use of a mouse.	Performance
UR TS.41	The GUI shall provide users with drop-down menus for commands to the system.	Performance
UR TS.42	The GUI shall provide context-sensitive on-line help.	Performance
UR TS.43	Operators will be able to manipulate intersection controllers if they have the proper privileges.	Manage Users
UR TS.44	Local agencies will be able to delegate control authority to another agency.	Operate Signals
UR TS.45	Operator shall be able to log in from a remote location and be able to operate the system.	Operate Signals
UR TS.46	The ATMS shall display status of system controllers.	Monitor Signals

Req. #	Requirement	Use Case
UR TS.47	The ATMS shall log and alarm equipment faults and errors.	Log Event Details
UR TS.48	The ATMS shall report events which are not faults or errors such as a cabinet door is open.	Monitor Events and Alarms
UR TS.49	The user interface shall provide geographically accurate maps in the project region.	Performance
UR TS.50	Users shall be able to zoom and pan maps to provide more detail views, through the use of a mouse.	Performance
UR TS.51	ATMS maps will allow the display of arterial incidents.	Performance
UR TS.52	Operators with proper access level shall be able to edit maps.	Manage Users
UR TS.53	The system shall be capable of generating maintenance reports.	Generate Maintenance Log Report
UR TS.54	ATMS shall be capable of automatically generating reports via time-of-day scheduling.	Generate Maintenance Log Report
UR TS.55	The system shall record actions taken and changes of status.	Log Event Details
UR TS.56	The system shall record operator actions in a system log.	Log Event Details
UR TS.57	The operator shall be able to add comments to the system event log.	Log Event Details
UR TS.58	The ATMS shall record when timing plan changes have occurred.	Log Event Details

Req. #	Requirement	Use Case
UR TS.59	The system shall provide mechanisms for auto-upload, auto-download and auto-compare.	Configure Operations
UR TS.60	The system shall provide on-screen display and editing of controller parameters.	Performance
UR TS.61	The system shall be capable of printing reports.	Generate Maintenance Log Reports
UR TS.62	Local agencies shall retain control authority.	Manage Users
UR TS.63	ATMS shall recognize groups of operators to which access privileges are allocated.	
UR TS.64	ATMS shall have different access levels.	Manage Users
UR TS.65	Access levels shall control access to functions.	Manage Users
UR TS.66	Access levels shall control access to equipment.	Manage Users
UR TS.67	The system shall allow multiple simultaneous operators to monitor controller behavior.	Performance
UR TS.68	The ATMS shall support an interface according to the Information Exchange Network standards.	Performance
UR TS.69	The ATMS shall provide the functionality required to support the requirements of the Countywide Arterial Management System.	Performance

Req. #	Requirement	Use Case
UR TS.70	At a minimum, per lane volume and occupancy between all major intersections (mid-block) shall be collected.	Measure Traffic
UR TS.71	Above data will be used for planning purpose, timing plan generation, and as input into incident detection and adaptive traffic control algorithms.	Data Archiving
UR TS.72	Detection technology shall be reliable and provide accurate data on a per lane basis.	Performance
UR TS.73	Detection technology shall be cost-effective on a life-cycle cost basis.	Performance
UR TS.74	Detection technology may be permanent or temporary.	Performance
UR TS.75	Detection technology shall perform in all weather conditions.	Performance
UR TS.76	It shall be possible to share real-time detector data (at a minimum volume, occupancy, and speed) among various jurisdictions in I-5/Telegraph Road Corridor.	Exchange Coordination Data
UR TS.77	Operation of a new ATMS shall not require staff dedicated to operations.	Performance
UR TS.78	Agency traffic engineering staff should be capable of being trained to operate the system.	Performance

Req. #	Requirement	Use Case
UR TS.79	ATMS computer equipment shall be capable of being maintained by the agency's IT staff.	Performance
UR TS.80	ATMS Commercial off the shelf software (COTS) shall not require obligatory maintenance contracts.	System
UR TS.81	COTS hardware and software shall be used wherever possible.	System
UR TS.82	Custom and proprietary hardware and software solutions shall be avoided wherever possible.	System
UR TS.83	The Commerce ATMS shall permit the selection of Caltrans cameras for viewing only.	View CCTV Image
UR TS.84	The Commerce ATMS shall recognize a police operator.	Manage Users
UR TS.85	The Commerce ATMS shall allow police operator to monitor equipment.	Manage Users
UR TS.86	The Commerce ATMS shall allow police operator to log event information.	Manage Users
UR TS.87	The Commerce ATMS shall report congestion by aggregating raw volume and occupancy data collected from one or more intersections to derive measures such as travel time and speeds.	Monitor Congestion

Req. #	Requirement	Use Case
UR TS.88	The Downey ATMS shall permit the control of CCTV cameras.	Control City Camera
UR TS.89	The Downey ATMS shall permit the viewing of video images from the CCTV cameras.	View CCTV Image
UR TS.90	The Downey ATMS shall allow operator to manage incidents on the city arterials.	Response to Incidents
UR TS.91	The Downey ATMS should interface to SYNCHRO.	Generate Timing Plan
UR TS.92	The Downey ATMS shall report congestion.	Monitor Congestion
UR TS.93	The La Mirada ATMS shall permit a County operator to operate the City's signals.	Control City Camera
UR TS.94	The La Mirada ATMS shall report congestion.	Monitor Congestion
UR TS.95	The La Mirada ATMS shall support remote display functions.	System
UR TS.96	The Santa Fe Springs ATMS shall be able to implement control strategies to mitigate against rail crossing closures.	Control Traffic
UR TS.97	The Santa Fe Springs ATMS shall support Econolite controllers.	Performance
UR TS.98	The Santa Fe Springs system shall respond to freeway incidents in an automated fashion by triggering a pre-defined response (such as timing plan changes and/or CMS message deployment).	Response to Incidents

Req. #	Requirement	Use Case
UR TS.99	The Santa Fe Springs ATMS shall accommodate transit priority.	Priority to Transit
UR TS.100	The Santa Fe Springs ATMS shall accommodate emergency vehicle pre-emption.	Priority to Emergency Vehicles
UR TS.101	The Santa Fe Springs ATMS shall incorporate above-surface detection.	Performance
UR TS.102	The Santa Fe Springs ATMS shall support dynamic message signs.	Control Signs